

Joint conference of the 4th Iconicity Seminar and
the 15th International Symposium on Iconicity in Language and Literature
February 21-23, 2026, Nagoya University, Japan

Iconicity and Handshape Type Frequency in Taiwan Sign Language

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Introduction-1

- Phonological systems usually prefer more economical/efficient forms that require less effort (ease of articulation).
- However, sign languages often use iconicity to coin signs for concrete objects (Taub 2001) at the cost of requiring more difficult (marked) handshapes in order to match the objects' physical shapes (Eccarius and Brentari 2010).

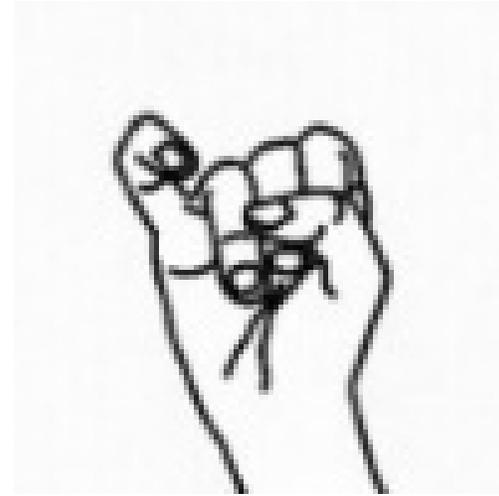
Introduction-2

- By contrast, signs for abstract concepts in sign language do not necessarily depend on physical shapes to match with and thus should be able to use easier (unmarked) handshapes.
- Moreover, frequency may modulate these effects:
 - Common handshapes may tend to be simpler (the law of abbreviation: Zipf 1949)
 - This powerful effect may reduce other influences on handshape difficulty, including concreteness

Easier vs. difficult handshapes in TSL



easier handshape “L”
(as in ALWAYS)



difficult handshape “curved-I”
(as in BUG/WORM)

Introduction-3

- Meanwhile, there are also multiple ways for signed nouns to be iconic (Mandel 1977, Müller & Fischer 2003, Nyst et al. 2022), and only some where the shape of the hand matches the shape of the object (substitutive depiction).
- Iconic signs also include:
 - ✓ manipulating imaginary objects (presentable action)
 - ✓ tracing out their shape in the air (virtual depiction)
 - ✓ pointing (e.g., at body parts) (presentable object)These actions do not necessarily depend on difficult handshapes.

Shape-based concrete word vs. non-shape-based (manipulating) concrete word



DEER



KEY

Predictions

1. Concrete signs should tend to use more marked handshapes than abstract signs.
2. Concrete signs should show greater variation in handshape markedness, reflecting the different types of iconicity.
3. Frequency will affect handshape markedness and modulate concreteness effects

Method

This study tests these predictions in Taiwan Sign Language using:

1. Handshape difficulty scores, a modification of the ease scores of Ann (2006)
2. Concreteness ratings for Mandarin translation equivalents (Lv 2023)
3. Handshape type frequencies (number of distinct signs containing a given handshape)
 - Known to correlate with handshape difficulty (Ann 2005): marked handshapes are marked in being both more difficult and rarer

Taiwan Sign Language (TSL)

- The native language of the Deaf in Taiwan (Tai & Tsay, 2015a,b, 2017, 2025)
- A branch of Japanese Sign Language: brought to Taiwan by deaf educators during Japan's occupation of Taiwan in 1895-1945
- Hard-of-hearing \approx 140,000; TSL users \approx 30,000

Data

- Taiwan Sign Language Online Dictionary
 - ✓ Currently 4,600 lexical signs
 - ✓ All signs were annotated with their initial handshape of the dominant hand.

Tsay, Jane, James H.-Y. Tai, Shih-kai Liu and Yijun Chen.
2026. *Taiwan Sign Language Online Dictionary*. 5th ed.
Chiayi: Taiwan Center for Sign Linguistics, National
Chung Cheng University, Taiwan.

<https://twtsl.ccu.edu.tw/>

TSL Online Dictionary

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Purpose

Acknowledgement

User's Guide

Handshape List

Location List

English ▾

Taiwan Sign Language (TSL) is the language used by the Deaf in Taiwan and is genetically related to Japanese Sign Language (JSL), which was brought to Taiwan by deaf educators during Japanese occupation of Taiwan in 1895-1945. After 1949, Chinese Sign Language (CSL) was brought to Taiwan. Therefore, some signs from CSL may also have been integrated into TSL. Recently, there have been many new signs that have been created with the times.

The compilation of the Taiwan Sign Language Online Dictionary was under the supervision of Prof. Jane Tsay and Prof. James H.-Y. Tai. The sign language research team of the Linguistics Institute at the National Chung Cheng University started the construction of the TSL Online Dictionary in 2001 with the supports from National Science Council, Taiwan. In the dictionary, each lexical item is linked to the video of the TSL sign. The dictionary is bilingual in the sense that all lexical items (signs) and the description of the signs have both Chinese and English translations (see Tsay 2019 for more details).

Manual Search

Alphabet List

Feature Search

More Info

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Handshape difficulty scores

- Handshape difficulty scores were calculated using a revised formula of the model of Ease of Handshape Articulation by Ann (2005, 2006) that captures a fuller range of variation.

A Model of Ease of Handshape Articulation (Ann 2005, 2006)

(4)

The five physiologically based criteria	
a. Muscle Opposition in Configuration	How much opposition exists between the muscles necessary to produce a configuration?
b. Support for Extension	Do the extended fingers have either (a) an independent extensor or (b) “sufficient support”?
c. Support for Flexion	Are the middle, ring, and pinky either all included or all excluded from this group of fingers?
d. Tendency to oppose the thumb	Does the thumb tend to oppose the relevant finger(s)?
e. Tendency to spread	Does the handshape rely on natural spreading of fingers?

The Ease Score Formula (Ann 2005, 2006)

$$\textit{Ease Score} = (\textit{Temporary Ease Scores} \times \textit{MOC}) + \textit{TOT} + \textit{TS}$$

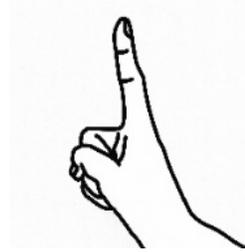
- Temporary Ease Scores: SE + SF
 - SE: Support for Extension
 - SF: Support for Flexion
- MOC: Muscle Opposition in Configuration
- TOT: Total Opposing Tensions
- TS: Total Spreading

Muscle Opposition in Configuration (MOC)

State	Score	Difficulty Level
Closed	0	Easiest
Bent	1	Moderate
Extended	2	Difficult
Curved	3	Most Difficult

Problem with Ann's model

Handshape 1



Configuration: Index finger extended

SE = 0

SF = 0

MOC = 2 (Extended, i.e., difficult level)

TOT= n.a. TS= n.a.

$$\begin{aligned} \text{Ease Score} &= (\text{Temporary Ease Scores} \times \text{MOC}) \\ &= ((0+0) \times 2) = 0 \end{aligned}$$

Problem: 23 out of the 62 handshapes in TSL were scored “0” (i.e., equally easy – can’t capture a full range of variation)

1



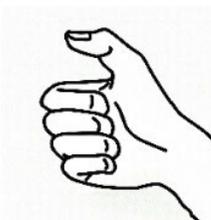
X



Open-A



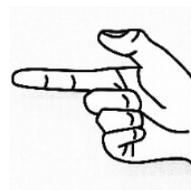
Flexed-A



L



Flexed-L



Bent-L



- Revised Scores of MOC

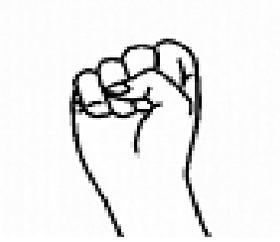
To avoid zero value after multiplication, all base physiological states were scored starting with 1, instead of 0.

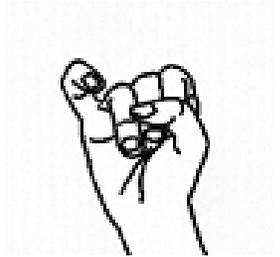
State	Score	Revised	Difficulty Level
Closed	0	1	Easiest
Bent	1	2	Moderate
Extended	2	3	Difficult
Curved	3	4	Most Difficult

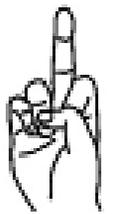
Modification: Handshape difficulty scores

- Range of the ease scores of Ann (2005, 2006):
0~4
- Difficulty scores: capture a fuller range of
variation 2~14

Easiest handshape vs. Difficult handshapes

S	2	
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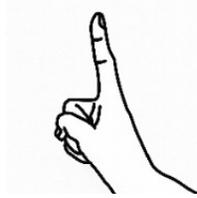
Curved-I	12	
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Middle	14	
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Difficulty scores in parentheses

1

(6)



X

(8)



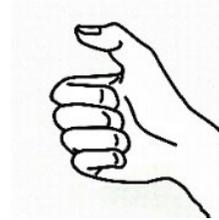
Open-A

(6)



Flexed-A

(8)



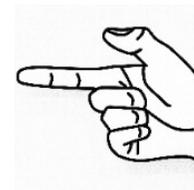
L

(6)



Flexed-L

(8)



Bent-L

(8)



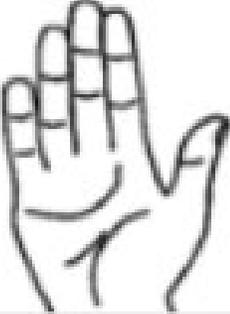
Handshape Type Frequencies in TSL

- There are 62 handshapes in TSL

TSL Handshape Inventory (Tsay & Tai, 2022)

- Handshape type frequencies were calculated from the signs in the Taiwan Sign Language Online Dictionary.

Most frequent handshapes

	583	14.18%
	574	13.97%
	307	7.47%

Least frequent handshapes

	1	0.02%
	1	0.02%
	1	0.02%
	1	0.02%
	1	0.02%
	1	0.02%
	1	0.02%

Concreteness ratings

- Mandarin concreteness ratings from Lv et al. (2023) were applied to their TSL translation equivalents.
- Affective Norms for Chinese Words with valence, arousal, dominance, and concreteness ratings for 4,030 words
- 7-point Likert scales ratings from 3,717 Chinese undergraduates

Semantic concepts shared across languages

- Spoken languages (Bates et al., 2003): “frequency effects ... reflect familiarity and accessibility at a conceptual level that is shared over languages”
- Sign languages (Bross, 2024): “Definitions viewing iconicity as a mapping between a signifier and some associated mental concept work best”
- Sign languages and gestures (Schiefner, 2025): “two unrelated languages would exhibit similar iconic mappings for concepts across the lexicon”

Data for statistical analyses

- 2,100 of the 4,600 signs in the TSL Online Dictionary have concreteness ratings based on Lv (2023).
- The following signs were excluded:
 - Compounds
 - Character signs (e.g., PERSON is signed by tracing the shape of the Chinese character 人)
 - Pointing signs (mostly using the index finger)
 - Synonyms (TSL signs that can be translated into more than one Chinese word)
- 1,371 signs were included in the statistical analyses.

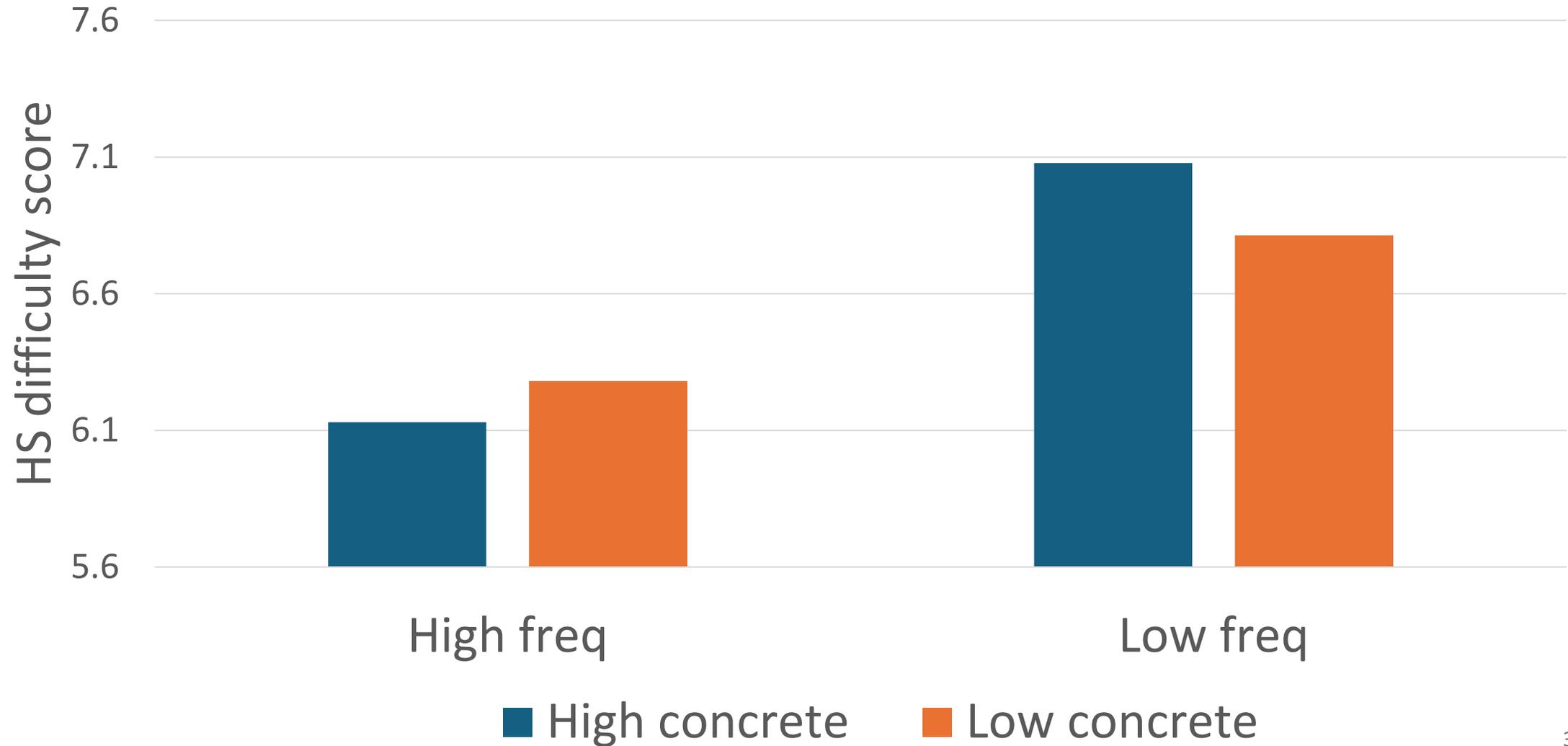
Statistical analysis

A two-way independent-measures ANOVA was used to predict difficulty scores from frequency and concreteness, treated as binary factors (below vs. above the median for each variable).

Results

- High frequency handshapes were significantly easier ($F(1, 1367) = 48.81, p < .0001$), an example of the law of abbreviation (Zipf 1949).
- Concreteness by itself had no effect ($F < 1$), but showed a marginal interaction with frequency ($F(1, 1367) = 14.26, p = .059$), in that concrete signs tended to have easier handshapes only for rarer handshapes
 - Semantic factors may influence handshape markedness more strongly when memory traces are weaker.

Effects of frequency and concreteness on handshape difficulty



Iconicity Type

- Iconicity type (shape-based vs. non-shape-based) was coded for a subset of items: the most concrete 152 signs and the most abstract 152 signs from the TSL Online Dictionary.

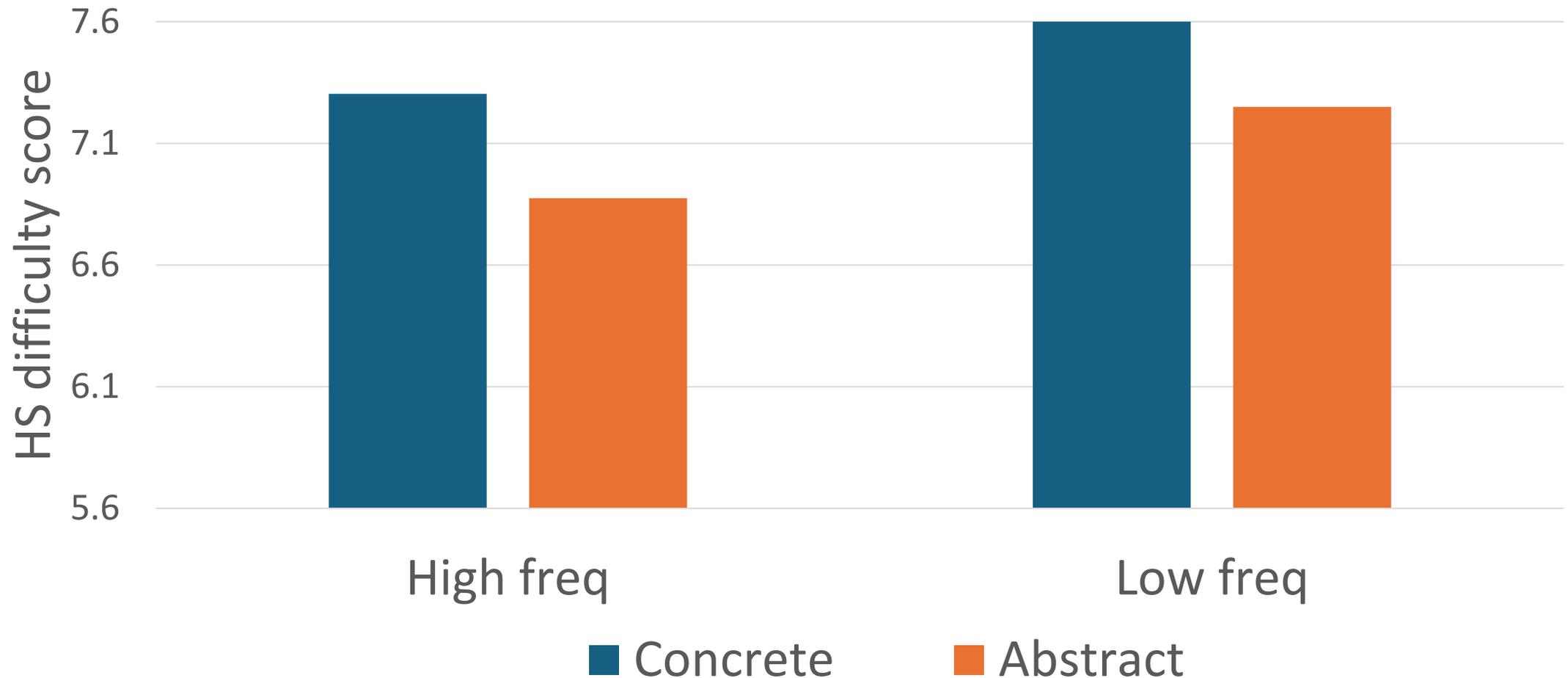
Concrete signs had higher variance in handshape type frequency

1. An F test on this subset showed that the concrete signs had significantly higher variance in log handshape type frequencies than the abstract signs ($F(151, 151) = 1.84, p < .001$)
 - This is consistent with the hypothesis that not all forms of sign iconicity depend on marked (rare) handshapes

Handshape type frequency was lower for concrete signs

2. A heteroscedastic unpaired t test found that the mean log handshape type frequency was significantly lower for concrete signs than for abstract ones ($t(278) = -4.95, p < .0001$)

Effects of frequency and concreteness on handshape difficulty in the iconicity-coded subset



Handshape difficulty score affected by
both handshape frequency and concreteness

An ANOVA showed that handshape difficulty score was affected by both handshape frequency and concreteness, consistent with the analysis of the full data set, although in this smaller and artificially restricted set neither effect reached statistical significance ($p > .05$)

Iconicity Type

Only two of the abstract signs were shape-based, while 110 (72%) of the concrete signs were shape-based in the dominant hand, though other types of iconicity were also used.

Shape-based abstract signs

POUR

(shape of kettle spout)



CROSS

(shape of legs)



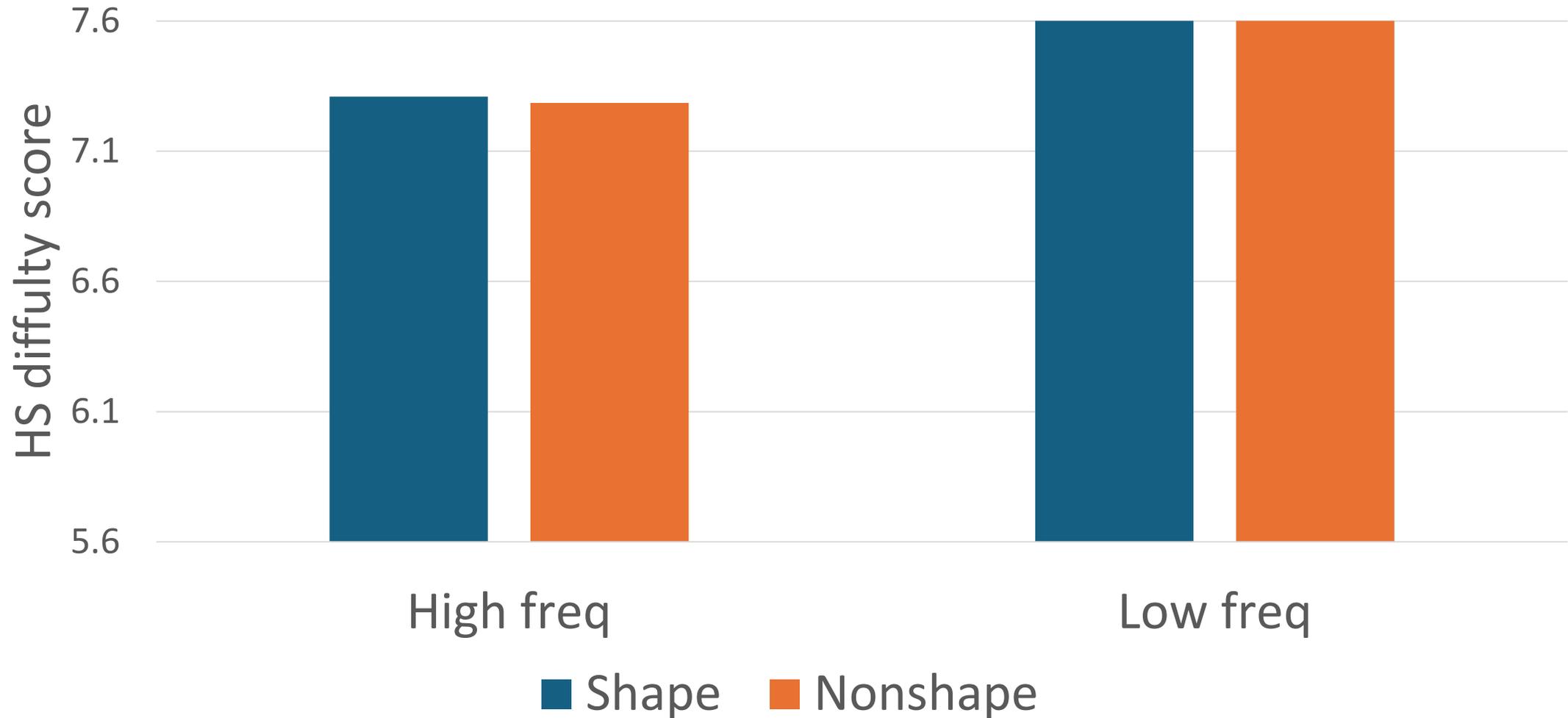
Concrete signs had more difficult handshapes

- An unpaired t test showed that concrete signs still had significantly more difficult handshapes than abstract ones ($t(302) = 2.07, p = .04$).

The lack of iconicity type effects on handshape difficulty in the concrete signs in the subset

ANOVA results predicted handshape difficulty scores from frequency and iconicity type just in the concrete signs, though the effect of frequency did not reach significance ($p > .05$).

The lack of iconicity type effects on handshape difficulty in the concrete signs in the subset



Discussions

It may be too restrictive to focus on:

- only the dominant hand (tends to be more marked than the nondominant one)
- only its shape (not location or orientation or movement)
- only the initial handshape (signs with handshape change may end with a less marked handshape)

Conclusions

1. Handshape difficulty was affected by both handshape frequency and concreteness.
2. High frequency handshapes were consistently easier.
3. Concrete signs tended to have easier handshapes, but only for rarer handshapes.
4. Handshape type frequency was lower for concrete signs.
5. Concrete signs had higher variance in handshape type frequency, but when iconicity was explicitly coded, shape-based concrete signs did not have more difficult handshapes than non-shape-based concrete signs.

Acknowledgements

- Research grant from the National Science and Technology Council, Taiwan (NSTC 114-2410-H-194-022)
- Taiwan Sign Language demonstrator Mr. Yushan KU
- Prof. James Tai
- Research assistants: Shihkai Liu, Chienchun Hsiao, Wanyu Chen, Anchen Chen

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